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THE PHILIPPINE
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D. GENERAL BIOLOGY, ETHNOLOGY, AND ANTHROPOLOGY

VOL. X SEPTEMBER, 1915 No. 5

NOTES ON JAPANESE LEPIDOPTERA AND THEIR LARVÆ: PART II [1]

By A. E. WILEMAN
(*Manila, P. I.*)

THREE COLORED PLATES

RHOPALOCERA

NYMPHALIDÆ

NYMPHALINÆ

APATURIDI

Genus APATURA Fabricius

Apatura FABRICIUS, Illiger's Magazin (1807), 6, 280; Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 160.

Apatura ilia Schiffermiller.

Larva and pupa of *Apatura substituta* Butler. Plate I, fig. 1, larva; fig. 2, head; fig. 3, cephalic horn, inside aspect; fig. 4, view of dorsal tubercle, lateral aspect; fig. 5, tail, dorsal aspect; fig. 6, food plant; figs. 7 and 8, pupa.

Japanese name, *ko-murasaki.*

Papilio (*Apatura*) *ilia* SCHIFF., Wien. Verz. (1776), 172; HÜBNER, Eur. Schmett. (1794), 1, figs. 115, 116; (1824–1826), figs. 809, 810; LEECH, Butterf. China, Japan, Corea (1892–1893), 1, 161; MIYAJIMA, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 134, Pl. XIV, fig. 6, ♂ (nec Hübn. = *substituta* Btlr.); MATSUMURA, Cat. Insect. Jap. (1905), 1, 7, No. 50; STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 161, Pl. 50c. ♂ ♀; Berge's Schmett.-Buch. Hoffmann (1899), 14, Pl. 8, figs. 5 *a*, larva; 5 *b*, imago, ♂; NAGANO, Nawa's Insect World [Konchū Sekai (Jap.)] (1909), 13, 375.

[1] The first paper of this series was printed in *This Journal, Sec. D* (1914), 9, 247–268, 3 pls.

Apatura substituta BUTLER, Cist. Entom. (1873), 1, 158; PRYER, Rhop. Nihon. (July, 1888), 22, Pl. 5, fig. 9, ♂; STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 163, Pl. 50d, ♂.

Papilio (*Apatura*) *clytie* SCHIFF., Wien Verz. (1776), 321; STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 162, Pl. 50c, ♂ ♀; MATSUMURA, Thousand Insects of Japan (Nihon Senchū Dzukai (Jap.)] (1907), 4, 79, Pl. 68, fig. 4, ♂ (nec Schiff = ? *substituta* Btlr.).

Apatura ilia var. *serarum* OBERTH., Étud. d'Ent. (1891), 15, 11, Pl. 1, fig. 8, ♂; STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 163, Pl. 50d, ♂.

Apatura ilia ab. *mikuni* WILEMAN, Entomologist (1910), 43, 93, ♂.

Apatura here FELDER, Wien. Ent. Mon. (1862), 6, 27; STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 162, Pl. 50e, ♂ ♀.

Apatura here ab. *sobrina* STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, Pl. 50e, ♀.

Apatura bunea HERRICH-SCHÄFFER, Schmett. Eur. (1844), 1, figs. 161, 164; STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 163, Pl. 55d, ♂.

The larva of *A. substituta* figured (Plate I, fig. 1) was taken May 23, 1901, at Kobe, Settsu Province, Honshu, on willow, Japanese name, *yanagi* (*Salix* sp.). A female imago emerged June 11, 1901, which I identified at the British Museum (Natural History) as *A. substituta* Butler. Another male imago, which emerged at Hakodate, Hokkaido (Yezo), August 5, 1902, and a female, locality and date unrecorded, are both referable to *A. substituta*. The larvæ from which these two specimens emerged were compared, previous to pupation, with the drawing of the larva from which the female imago emerged June 11, 1901, and were found to be identical.

Apatura substituta is placed by Leech and Stichel as a form or variety of *A. ilia* Schiff., and I am content, for the present, to leave it as a synonym of that species. At the same time I am inclined to think that, for reasons which follow, it is a distinct species, and not a subspecies nor a variety. Stichel [2] remarks of *A. substituta* as follows:

> In Japan, the species (*A. ilia* Schiff.) is represented by *substituta* Btlr. (Plate 50d) which is very similar to *metis* Frr. (and therefore often confounded with it). The ground-colour of this form is generally darker, the eye-like spots of both wings are not obsolescent, the submarginal spots of the hindwing elongate-ovate or rounded-quadrate, instead of arrowhead-shaped or luniform as in *metis*, and on the underside the band of the hindwing is more distinctly white, contrasting with the ground. Some specimens (from Korea) have the bands or the upperside whitish and therefore recall *bunea*.

[2] Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 163.

I may remark that these Korean specimens referred to by Stichel, which recall *A. bunea,* may be referable to the aberration *A. mikuni* Wileman, which I described from Mikuni, Bungo Province, Kyushu,[3] as "possibly a dimorphic form of *A. ilia* var. *substituta;*" but as the type is not at hand, I am unable to say positively and cannot compare it with Seitz's figures of *bunea* or *substituta.*

Stichel catalogues many forms of *A. ilia,* but the names appearing in the synonymic caption seem to be the only ones connected in any way with China and Japan.

Of *Apatura ilia* Schiff. (Seitz, 1, Plate 50c) (= *Papilio iris* Esp.) Leech remarks that "typical specimens of *ilia* are either exceedingly local, or of very rare occurrence in eastern Asia," and Seitz does not record it from Asia. Matsumura in his Catalogus Insectorum Japonicum (sic) mentions that it is found in Honshu. No doubt his *ilia* Hübn. equals *substituta* Btlr., as he does not mention *substituta* in his catalogue. *Apatura ilia* seems to be confined to Europe.

Apatura clytie Schiff. (= *iris* Esp., *julia* Schrk., *astasia* Hbn.) (Seitz, 1, Plate 50c), according to Stichel, also is confined to Europe. Matsumura [4] records it as a variety of *A. ilia* from the four islands of Hokkaido (Yezo), Honshu, Shikoku, and Kyushu and from Korea and China; this also seems to be an error for *A. substituta,* as his figure, apparently, represents either *substituta* Butl., or *mikuni* Wileman, not *clytie* Schiff.

Apatura substituta Butl. (Seitz, 1, Plate 50d) is the common form (?) of *ilia* in Japan, and is recorded by Stichel from the Japanese islands of Honshu and Hokkaido (Yezo) and from northern China, Korea, and Amurland. Pryer records it from Honshu as *ilia,* from July to September. I have taken it in Honshu from June to September, in Kyushu in June and July, and in Hokkaido (Yezo) in July and August. The larva appears in June, and there seems to be only one brood of the butterfly in the year. It is to be noted here that Miyajima [5] figures *A. ilia* Hübn., male, and Matsumura [6] figures *A. ilia* var. *clytie* Schiff., male, as being the form of *Apatura ilia* occurring in Japan. Both the figures given by these authors neither agree in the

[3] *Entomologist* (1910), 43, 93.

[4] Thousand Insects of Japan (Nihon Senchū Dzukai) (1907), 4, 79, Pl. 68, fig. 4, ♂.

[5] Japanese Butterflies (1904), 134, Pl. 14, fig. 6, ♂.

[6] Thousand Insects of Japan (1907), 4, 79, Pl. 68, fig. 4, ♂.

former case with the figure given by Stichel[7] for *ilia*, male, nor in the latter case with the figure given by him for *clytie*, male,[8] but they both agree well with the figure given by Stichel for *substituta*, male.[9] Matsumura in referring to his figure remarks in a note that "this variety has the markings very distinct but the ground-color is ashy-white; it occurs in Kyushu but is rare." His figure, I believe, represents *mikuni* Wileman, male,[10] also taken in Kyushu, in which the tawny-orange spots and bands of both wings are replaced by white ones. Apparently these spots and bands in his figure are white, not tawny-orange; and, if so, the figure represents *mikuni*, a dimorphic form of *substituta*.

Apatura here Feld. (Seitz, 1, Plate 50e) ab. *sobrina* Stichel (Seitz, 1, Plate 50e) is from eastern, central, and northern China and seems to have been erroneously recorded from Japan by Felder.

Apatura serarum Oberth. (Seitz, 1, Plate 50d) (male = *phaedra* Leech) from western and central China and Yunnan.

Apatura ilia ab. *mikuni* Wileman (male, type unfigured) from Honshu, Japan = ? dimorphic form of *A. substituta* Butl. The tawny-orange spots and bands of *substituta* are replaced by white.

The reason why I think *Apatura substituta* Butl. is entitled to rank as a species is because the larva apparently differs from that of *ilia* Schiff., which is described by Stichel[11] as follows:

> Larva of the species (*A. ilia* Schiff.) adult 4–5 cm, dirty green, similar to that of *iris* Linn. (nec Esp.) in shape and markings, but the reddish horns on the head with black stripe, the anterior part of the body with two red-edged yellow lines, the body from the center backwards on each side with 5 red-margined yellow oblique stripes which extend over two segments, anal processes and legs blue-green. Its habits similar to those of *A. iris* Linn.; feeding especially on *Populus tremula, P. pyramidalis*, and on various willows, like *Salix caprea, viminalis*, and *rosmarinifolia*. Pupa greenish, carinate dorsally, the back, the wing cases and the processes of the head edged with yellow.

A comparison of Stichel's description of the larva of *A. ilia* with my original figure of the larva of *substituta* shows the following differences: "Anterior part of the body with two red-edged yellow lines;" *substituta* shows one yellow longitudinal line only, not red-edged, extending from the head to the end of

[7] Macrolep. of the World, Faun. Pal. (1909), 1, 161, Pl. 50c, ♂ ♀.
[8] Opus cit., 162, Pl. 50c, ♂ ♀.
[9] Opus cit., 163, Pl. 50d, ♂.
[10] *Entomologist* (1910), 43, 93, unfigured, ♂.
[11] Opus cit., 162.

the sixth segment (counting from and including the head). *Apatura substituta* has the same number of yellow oblique stripes, namely five, which are not red-margined. No mention is made by Stichel of the dorsal tubercle or spine on segment 8; this is an important point, and if this spine does not exist in the larva of *ilia*, it at once separates the two species. A figure of this dorsal spine is given in Plate I, fig. 4; apparently it is composed of four small tubercles. As the larva is represented in fig. 4 in a lateral position, I am unable to say positively whether this spine is single or paired on the dorsum. The artist did not draw a figure showing an upper dorsal aspect of the larva, and I made no note at the time as to whether the spine on the dorsum was single or paired. It is probably paired. However, this point is of minor importance, as *ilia* apparently possesses no dorsal spine.

A reference to the figure of this larva given in Berge's Schmetterling-Buch shows no dorsal spine nor does mention of it appear in his description. Lang [12] remarks of the larva of *ilia* that it is—

> very similar to that of *iris* Linn., but somewhat smaller and of a yellowish colour, except on the ventral surface. The cephalic horns are bordered with yellow. Feeds on *Salix* and several kinds of *Populus*, chiefly *Populus alba*.

Lang also does not mention the presence of a spine on the dorsum, and as these two authors could hardly have overlooked such an important character, I believe that *substituta* is a species distinct from *ilia*.

Pupa.—The pupa of *Apatura substituta* is figured on Plate I, figs. 7, 8. Pryer states that "the green pupa mimics a young willow leaf, both in shape and colour." It has faint white oblique stripes on the dorsum, and with the exception of this agrees with Stichel's description of the pupa of *ilia*.

Genus VANESSA Fabricius

Vanessa Fabricius, Illiger's Magazin (1807), 6, 281; Stichel, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 200.

Vanessa canace Linnæus.

Plate I, fig. 17, larva; fig. 18, food plant.

Japanese name, *murasaki-tateba* or *ruri-tateba*.

Papilio canace Linn., Syst. Nat. (1767), 12, 779.

Vanessa canace Leech, Butterf. of China, Japan, Corea (1892–1893), 1, 255; Stgr. and Rebel, Cat. Lep. Pal. (1901), 1, 26, No. 163; Kershaw, Butterf. Hongkong (1907), 41, Pl. V, fig. 2, ♀; Pl. 6a, fig. 5, larva; fig. 6, pupa; Miyajima, Jap. Butterf. [Nihon Chōrui

[12] Butterfl. Eur. (1884), 157, Pl. 35, fig. 1.

Dzusetsu (Jap.)] (1904), 113, Pl. X, fig. 8; MATSUMURA, Cat. Insect. Jap. (1905), 1, 9, No. 68; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 91, Pl. 70, fig. 12, ♀; STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 205, Pl. 63c; FRUHST., Seitz's Macrolep. of the World, Faun. Indo-austral. (1912), 9, 527.

Papilio charonia DRURY, Ill. Exot. Entom. (1710), 1, Pl. XV, figs. 1, 2.

Vanessa charonia PRYER, Rhop. Nihon (1889), 27, Pl. VII, fig. 4.

Vanessa glauconia MOTSCHULSKY, Étud. Entom. (1857), 6, 28 (= *no-japonica* Siebold).

Stichel and Fruhstorfer [13] give the following races and subspecies of *Vanessa canace* which are connected with China, Japan, and Formosa, and I have given a précis of their remarks. Fruhstorfer says:

V. canace, widely distributed from North to South, inclines to geographical differentiation. Two general types can be recognized: The first, peculiar to the Japanese and Philippine Islands, displays before the apex of the forewing a white spot, whereas in the second type, which belongs to the Indian-Malayan region, this spot is blue.

Of the first group Fruhstorfer records the three following insular races:

RACES AND SUBSPECIES OF VANESSA CANACE

WHITE-SPOTTED RACES

Vanessa no-japonica Siebold (= *glauconia* Motsch.); subspecies insular race (1, 206, Pls. 63c and d, ♂ ♀, figured as *charonia* Drury; 9, 427); Siebold's older name of *no-japonica* has to be retained instead of *glauconia* Motsch. for this subspecies. From Japan (Honshu), also in the southern Japanese islands as far as Oshima and Okinawa in the Loochoo Islands (Ryukyu), Korea. The female in two forms (? seasonal).

Vanessa siphnos Fruhst.; subspecies, insular race (? seasonal form), 1, 206; 9, 527, Pl. 117, fig., ♂). From Ishigakishima, most southern of Loochoo Islands (Ryukyu).

Vanessa benguetana Semper (9, 527); subspecies, very near to *no-japonica* Seib.; from northwestern Luzon, Philippines, at 3,800 feet [about 1,200 meters].

I have taken this form in Luzon at from 1,700 to 2,000 meters (5,000 to 6,000 feet), in November and December, from Baguio up to the Cervantes trail leading to Bontoc. It was of frequent occurrence on the Cervantes trail at about 2,000 meters elevation below Pauai (Haight's), but not many specimens were observable at about 2,100 meters, which is the elevation of Haight's place. The female of this species is a remarkably large and handsome form. I have also found the larva feeding on a species of *Smilax* and observed the female ovipositing on the same plant, which grows commonly in the mountains of Benguet. Semper records it during July and August.

[13] Seitz's Macrolep. of the World, 1, 205, and 9, 527.

With *Vanessa drilon* Fruhst. the series of the blue-banded subspecies begins. In contrast to *no-japonica* the white spotting on the apical area of the forewing is reduced. The female hardly differs from the male.

BLUE-BANDED SUBSPECIES

Vanessa drilon Fruhst. (9, 527). From Formosa, 1,500 to 2,000 meters (4,000 to 6,000 feet), at Chip-chip and on the borders of Dragon and Lé-hiku Lakes.

Vanessa charonides Stichel (1, 206, Pl. 63, ♂, and underside, figured as *canace* Linn. (9, 328). From eastern Siberia (Amurland and Ussuri), western China, and Korea.

Vanessa charonia Drury (1, 206; 9, 528). From eastern and southern China, Hongkong, ? Tonkin, Assam, Hainan; larva on *Smilax*, gregarious in December.

All the forms found in continental India are comprised under the general name of *canace*, but it is not necessary to refer to them here.

The larva figured (Plate I, fig. 17) was taken October 15, 1900, at Yoshino, Yamato Province, Honshu, on a spiny creeper which my Japanese collector named *sankirai* (*Heterosmilax japonica* Kth.). Pryer and Miyajima, however, give the name of the food plant as *saru-tori-ibara* (*Smilax china* Linn.), and this is probably the correct name of the creeper figured (Plate I, fig. 18). The larva also appears to feed on *Smilax china* in Hongkong according to Kershaw, and I have found it on a species of *Smilax* in the mountains of Benguet subprovince, Luzon. I have also found the larva on a species of lily growing in a garden at Atami, Honshu, feeding in a semigregarious state. A male imago emerged from the pupa resulting from my larva, which is probably referable to the form *glauconia* = *no-japonica*, but the date of emergence was not recorded.

Another larva was taken at Tokyo May 2, 1894. The larva appears to be very liable to attack by ichneumon flies, as I have taken it on many occasions, but have only once succeeded in rearing it, all the other larvæ having been infested with ichneumons and dying before coming to maturity. My figure of the larva is not very good, as it was just preparing to pupate. The one given by Kershaw in Butterflies of Hongkong and south-eastern China is an excellent figure, and his description of the full-grown larva, which is given below as well as descriptions of the ova and pupa, agrees with my figure.

Ova sub-conical, multi-angled longitudinally, the angles whitish, the rest green. Laid singly on the upper side of leaves of *Smilax china* Linn., a very prickly climber with scarlet berries, native to China, Cochin China and Japan. Fam. *Liliaceae*.

Larva, very young; head black, general colour shiny yellow brown, base of spines light yellow. Later, general colour grayish maculated with dark brown, the yellow of the base of the spines suffused and almost forming a

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Larva, very young; head black, general colour shiny yellow brown, base of spines light yellow. Later, general colour grayish maculated with dark brown, the yellow of the base of the spines suffused and almost forming a

broad yellow ring on each segment. Branches of spines nearly black. Full grown, each segment narrowly banded transversely with black and pale yellow, these latter bands narrower than the black. Each segment also broadly banded transversely with orange, spotted with black, the spines being set in these bands. Seven longitudinal rows of stout, pale yellow spines, or processes, spined laterally at the top with black and up the stems with pale yellow spinelets, the tips black. Head black bristly with black hairs, with the suture narrowly marked in orange. The first spine of the central dorsal row is on the fifth segment, the last spine on the twelfth or penultimate segment. The two last segments irregularly marked with black and orange, with a large sub-circular black spot above the anus. Prolegs black, ringed at the base with orange. Underside chiefly black, but banded narrowly with whitish, something like the upper surface. After the late molts, when nearing pupation, the stems of the spines become white, and the pale yellow transverse bands on the body also are nearly white.

Pupa angular, two rows of sharp processes down the back of the abdomen, and other very small processes on the dorsal surface. Head deeply cleft, the two parts sharply pointed and curved inwards. General colour deep purple-brown, variously marked with reddish; a silver marking on each side of the back of the thorax, each marking divided into two by a transverse brown line. After some days the four lowest processes (just above the silver spots) become dark red-gold. Attached by the tip only, without a band.

Although the eggs seem to be always laid on *S. china*, and the larvæ are there found, yet they will generally eat several other species of *Smilax*.

The following descriptions of the larva and pupa are taken from various authors:[14]

Vanessa canace Linn. "Larva. Segments alternately orange and white, with numerous black spots on the orange segments and black streaks on the white; seven white, branching, black-tipped spines on each orange segment." (*Hampson.*)[15]

"Pupa. Variegated reddish brown, with frontal gold and silver spots; head produced and bifid." (*Hampson.*)

Vanessa canace, race *haronica* Moore. "Larva. Light red; spotted with black, the segments divided by blackish and purple lines; anal segment slightly humped; segments armed with eight longitudinal rows of yellow branched spines: head and legs black. Feeds on *Smilax*." (*Moore.*)[16]

Pupa.—"Reddish brown; abdominal segment with two dorsal rows of small reddish pointed tubercules; thorax angular; head-piece produced and bifid." (*Moore.*)

Imago.—"Usually a very wary, easily scared insect, it is occasionally seized with unaccountable fits of boldness, and I have more than once seen it settle again and again on a moving jinrikisha in a crowded street. It is on the wing throughout the year, though most numerous in autumn.

[14] See Fauna of Br. India, Butterflies (1905), 1, 372.

[15] *Journ. Asiat. Soc. Beng.* (1888), pt. 2, 355.

[16] Lepidoptera of India (1899–1900), 4, 94, Pl. 315, figs. 2, 2a, 2b, larva and pupa, ♂ ♀.

The sexes are similar, but the white sub-apical marking on the upper side of the forewing is larger in the female, than in the male." (*Kershaw.*)

"Common all over Japan and Korea. It is a variable species in the contour of the wings, width of the blue submarginal bands, and the size and colour of the costal spots, which may be either blue (*canace*), or white (*glauconia*), the blue submarginal band of the forewing, which usually ceases at its junction with the larger costal spot, is in some specimens carried up as far as the apical spot, noticeably so in specimens taken in the mountain districts of central Japan in October. * * * So far as I know the var. *glauconia* appears to be confined to Japan and the Loochoo Islands. * * *." (*Leech.*)

The adult is very partial to the gummy exudations of wild cherry and other trees and to the sap issuing from *Cossus* burrows in oak trees. As Kershaw observes, it is occasionally very bold. Individuals of this species have settled on my butterfly net while I held it and on my white helmet. It is fond of sitting on wet places on the roads and of flying about late in the afternoon just before dusk, when it is more than usually audacious.

Matsumura records *Vanessa glauconia* Motsch. (= *no-japonica* Sieb.) from the Japanese islands of Hokkaido (Yezo), Honshu, Shikoku, and Kyushu, and I have taken it in Honshu and Kyushu in various localities on the mountains and plains from May to October. It undoubtedly hibernates in the imago state, as I have taken specimens flying in the months of March and April at Tokyo. I have observed it in Japan as high as from 1,300 to 1,700 meters (4,000 to 5,000 feet). There are probably two if not three broods in the year according to its geographical range. In Hokkaido there is probably only one brood, as the summer is very short.

Genus **DIAGORA** Snellen

Diagora japonica Felder.

Plate III, figs. 10 and 11, young larva, lateral and dorsal aspects; figs. 7 and 9, adult larva; fig. 8, cephalic horn, enlarged; fig. 1, head, enlarged; figs. 2, 3, 4, and 5, horn on segments 3, 6, 8, and 11, respectively, enlarged; fig. 6, anal horns, enlarged; figs. 12 and 13, pupa.

Japanese name, *gomadara-chō*.

Apatura japonica FELDER, Wien. Ent. Mon. (1862), 6, 27.

Euripus japonica PRYER, Rhop. Nihon. (July, 1888), 23, Pl. 5, fig. 8.

Hestina japonica LEECH, Butterf. China, Japan, Corea (1892–1893), 1, 146, Pl. 20, figs. 5 and 6, vars.; MIYAJIMA, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 136, Pl. 14, fig. 7, ♂; MATSUMURA, Cat. Insect. Jap. (1905), 1, 7, No. 48; MATSUMURA, Thousand Insects of Japan [Senchū Dzukai (Jap.)] (1907), 4, 80, Pl. 68, fig. 5, ♀.

Diagora japonica STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 167, Pl. 56b, ♂; 56c, ♀.

Hestina australis LEECH, Butterf. China, Japan, Corea (1892–1893), 1, Pl. 20, fig. 5, ♂.

Diagora australis STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, Pl. 56c; NAWA, Insect World [Konchū Sekai (Jap.)] (1902), 6, 134, Pl. 4, larva, pupa, imago, ♂ ♀.

Diadema diagoras HEW., Exot. Butt. (1863), 3, Pl. 1, fig. 1 (= *japonica* Feld.).

Hestina subviridis LEECH, Entom. (1891), 24, suppl. 27.

Diagora subviridis STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, Pl. 60b, sex?

Hestina yankowskyi GROSE-SMITH and KIRBY, Rhop. Exot. (1891), pt. 16, 2, Pl. 1, figs. 3 and 4, ♂.

Diagora yankowskyi STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 167.

Hestina subviridis var. *intermedia* LEECH, Butterf. China, Japan, Corea (1892–1893), 1, 145.

Diagora subviridis var. *intermedia* STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 167.

Hestina japonica var. *chinensis* LEECH, Butterf. China, Japan, Corea (1892–1893), 1, Pl. 20, fig. 6, ♂.

Diagora japonica var. *chinensis* STICHEL, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, Pl. 56c.

Stichel remarks that *Diagora subviridis* Leech is presumably a subspecies of *persimilis* Westwood, the nymotypical form of which inhabits the Himalayas; *D. subviridis* differs from *persimilis* only in the whitish green streaks and spots being enlarged, the underside being of a greenish tint. *Diagora subviridis*, with its aberrations or forms of *yankowskyi*, *intermedia*, and *chinensis*, is the Chinese race or subspecies, while *japonica* Feld., with its aberration *australis*, is the Japanese race or subspecies. Stichel places all of these under *subviridis*. *Diagora japonica* Felder, however, should have precedence as the type, since it was described in 1862 and *subviridis* in 1891.

Plate III, figs. 10 and 11, represent the young larva of *Diagora japonica* Felder, taken at Kobe, Settsu Province, Honshu, in October, 1900, on a tree named in Japanese *enoki* (*Celtis sinensis* Pers.). This larva, which is given in lateral and dorsal aspects, I failed to breed.

Plate III, figs. 7 and 9, represent an adult larva of *D. japonica* taken in June, 1901, at Yoshino, Yamato Province, Honshu, also on enoki.

Fig. 7 represents this larva on June 8, 1901, and fig. 9 represents it on June 29, 1901. About the latter date it was preparing to pupate, but unfortunately died before it effected the pupal metamorphosis. Therefore I was unable to obtain the imago. However, I have bred *D. japonica* from similar larvæ on previous

occasions and have no doubt as to the identity of the larva figured. My larva, moreover, agrees well with the figures and description given by Nawa.[17]

Nawa states that "the young larvæ [of *Diagora japonica*] hatched from the third brood of the imago, appearing at Gifu, Honshu, from the middle of September to the beginning of October, are at first ashen-grey in colour and during hibernation rest on dead enoki leaves their color assimilating well with the dry, dead leaves so that they are not easily discovered."

I have found them myself as late as February concealed in crevices of the bark. Nawa further states that "when full grown the larva is green with two bifurcated horns on the head; two large horns on segment 7 (not including head as first segment), smaller horns on segment 2, 5, 10 and two on the anal segment." This agrees with the number of horns on my larva.

The pupa is described by Nawa as light green. It is represented with oblique white streaks in his figure, but Nawa does not mention these streaks in his description. I bred an imago of *D. japonica* from a light green pupa with oblique white streaks on May 18, 1901, so that they evidently exist as figured by Nawa. Pryer remarks of the larva:

it hibernates on the bark of the twigs of the tree (enoki), and is then grey, but as soon as the leaves appear in spring it changes its skin and becomes green. It is of the usual *Apatura*, tapering, cylindrical shape, with strongly bifurcated head.

The following description is taken from my original figure. In the description I have taken the head as the first segment, so that the horns are placed upon segments 3, 6, 8, and 11, respectively, instead of, as in Nawa's description, on segments 2, 5, 7, and 10. Nawa counts the segment succeeding the head as segment 1, while I count the head as segment 1.

Larva.—Length, 56 millimeters when full grown. Apaturid shape; green; two cephalic horns; five faint yellowish, oblique, lateral stripes; whitish, longitudinal, subspiracular (or suprapedal) stripe from head to tail; short white longitudinal line from head to first pair of spines on segment 3; anal segment strongly bifurcated into two parallel horns. Nawa does not mention the oblique stripes in his description.

It appears from Nawa that Pryer gives the time of appearance of the imago as June, August, and October. Miyajima gives it as June and September. Both Pryer and Miyajima are agreed that there are only two broods of the insect in the year. Nawa

[17] Insect World (Konchū Sekai) (1902), 6, 143, Pl. 4, larva, pupa, imago, ♂♀.

states that there are three annual broods in Gifu, Honshu, namely:

Brood 1. From May to the middle of June.
Brood 2. From end of July to the middle of August.
Brood 3. From the middle of September to the commencement of October.

But few specimens of the imago are seen flying from the middle of August to the middle of September, and very few emerge during this period. The imagoes of the third brood die after ovipositing, and their young larvæ hybernate.

Matsumura records this species from the four islands of Hokkaido (Yezo), Honshu, Shikoku, and Kyushu and from Formosa and Korea, and Seitz records it from China and Japan.

It would be interesting if some entomologist were able to breed *Diagora persimilis* Westwood,[18] in order to discover if the larva is the same as that of *japonica* Leech, since Stichel states that *subviridis* Leech, a form of *japonica* Leech, is presumably a subspecies of *persimilis*. Matsumura gives *nire* (*Ulmus parvifolia* Jacq.) as a food plant of *japonica*.

LYCÆNIDÆ

Genus ZEPHYRUS Delman

Zephyrus DELMAN, Kong. Vet.-Akad. Hand. (1816), 37, 62, 90; SEITZ, Macrolep. of the World, Faun. Pal. (1910), 1, 269.

Zephyrus orientalis Murray.

Plate I, figs. 12 and 13, larva, lateral and dorsal aspects; fig. 14, food plant; figs. 15 and 16, pupa, lateral and dorsal aspects.

Japanese name, *ō-midori-shijimi*.

Dipsas orientalis MURRAY, Ent. Month. Mag. (1875), 11, 169.

Thecla orientalis JANSON, Cis. Ent. (1877), 2, 156; PRYER, Rhop. Nihon. (July, 1888), 14, Pl. IV, figs. 8a and 8b.

Zephyrus orientalis LEECH, Butterf. China, Japan, Corea (1892–1894), 2, 376; STGR. and REBEL., Cat. Lep. Pal. (1901), 1, 71, No. 480; MIYAJIMA, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 180, Pl. XX, fig. 3, ♂; 4, ♀; MATSUMURA, Cat. Insect. Jap. (1905), 1, 18, No. 140; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 214, Pl. 75, fig. 3, ♂; SEITZ, Macrolep. of the World, Faun. Pal. (1910), 1, 269, Pl. 73h, ♂♀ and underside.

Zephyrus diamantina OBERTH., Étud. d'Ent. (1880), 5, 18, Pl. i, fig. 1.

Zephyrus cognata STGR., Rom. Mém. Lép. (1892), 6, 152, note.

Zephyrus suffusa LEECH, Butterf. China, Japan, Corea (1892–1894), 2, 377, Pl. XXVII, fig. 14, ♂; SEITZ, Macrolep. of the World, Faun. Pal. (1910), 1, 269, Pl. 73h.

[18] Since writing the above I have discovered a reference to the pupa of *Diagora persimilis* Westw. See Mackinnon, *Journ. Bomb. Nat. Hist. Soc.* (1897), 11, 369, Pl. 4, fig. 8, pupa.

The larva figured (Plate I, figs. 12 and 13) was taken June 14, 1902, at Hakodate, Oshima Province, Hokkaido (Yezo), on dwarf oak, Japanese name, *ko-nara* (*Quercus glandulifera* Bl.); it pupated June 21, and a male imago emerged, date unrecorded, which I identified at the British Museum (Natural History) as *Zephyrus orientalis* Murray. Another male pupated at Kobe, Settsu Province, Honshu, May 11, 1901, and emerged June 1, 1901.

Larva.—Seitz describes the larva as ashy gray, with darker markings, the segments projecting laterally; lives until June on oak. The following description is taken from my original figure: Length, 20 millimeters. Ashy-gray; mediodorsal longitudinal black line edged by white lines on each side; darker lateral oblique streaks edged with white; segments on dorsum projecting acuminately, slightly hairy; the segments projecting laterally above legs.

Pupa.—The pupa is attached by a silken tail pad and abdominal girdle.

Miyajima states that in Japan the larva feeds on evergreen oak, Japanese name, *aka-gashi* (*Quercus acuta* Thunb.). Matsumura and Seitz record the species from Hokkaido (Yezo) and Honshu and also from Korea, central and northern China, and eastern Siberia (Amurland). Matsumura gives *kashiwa* (*Quercus dentata* Thunb.) and *miyama-hannoki* (*Alnus viridis* var. *sibirica* Rgl.) as food plants of the larva. I have taken it at Hokkaido, Honshu, and Kyushu from June to July. Pryer records it in Japan on the plains from May to July and on the mountains from July to August. Leech states that it occurs plentifully all over Japan and at Gersan, Korea, from the end of June to the beginning of August.

Zephyrus attilia Bremer.

Plate I, fig. 11, larva.

Japanese name, *mizuiro-onaga-shijimi.*

Thecla attilia Bremer, Bull. Acad. Pétr. (1861), 3, 469; Bremer, Lep. Ost.-Sib. (1864), 24, Pl. 2, fig. 3; Murray, Ent. Month. Mag. (1874), 11, 168, ♀; Pryer, Rhop. Nihon. (July, 1888), 15, Pl. 4, fig. 11; Stgr., Rom. Mém. Lép. (1892), 6, 153.

Zephyrus attillia Leech, Butterf. China, Japan, Corea (1892–94), 2, 392; Stgr. and Rebel., Cat. Lep. Pal. (1901), 1, 71, No. 483; Miyajima, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 185, Pl. XX, fig. 12; Matsumura, Cat. Insect. Jap. (1905), 1, 18, No. 142; Matsumura, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 122, Pl. 74, fig. 20, ♀; Seitz, Macrolep. of the World, Faun. Pal. (1910), 1, 272, Pl. 74d, ♂ ♀.

Zephyrus attilia subgrisea Wileman, Entomologist (1911), 44, 55 (aberration).

The larva figured (Plate I, fig. 11) was taken May 21, 1901, at Yoshino, Yamato Province, on evergreen oak, Japanese name, aka-gashi (*Quercus acuta* Thunb.). A female imago emerged June 8, 1901. The larva also feeds on the dwarf oaks, Japanese name, *kunugi* (*Quercus serrata* Thunb.) and ko-nara (*Quercus glandulifera* Bl.). Graeser found the larva on *Quercus mongolica* at Chabarowka, Amurland, eastern Siberia.

It is an interesting fact that the larva of this species emits a faint sound which resembles the feeble clucking of a hen. One male and four female imagoes also emerged from larvæ similar to the one figured on June 7, 8, 9, 11, and 12, 1901.

Larva.—Seitz describes the larva as pale green with yellow dorsal dashes. Until the end of May, found on *Quercus mongolica*, and frequently infested with *Tachina*. The following description is taken from my original figure: Length, 20 millimeters. Dark yellowish green with lateral yellow oblique streaks; dorsum on segments 5 to 11 acuminate and spined with a few stiff hairs; a slender whitish longitudinal subdorsal line from head to segment 5.

Matsumura records the species from Hokkaido (Yezo) and Honshu and from China, Korea, eastern Siberia (Ussuri and Amurland), and Manchuria. I have taken it from June to July in Honshu and Kyushu, and Pryer records it from May to July.

Zephyrus attilia ab. *subgrisea* Wileman was described from two specimens taken in Yamato Province, Honshu, and as it has not been previously figured, a figure of the imago is given on Plate III, fig. 14. The original description is also quoted beneath for convenience of reference. It may possibly turn out to be a distinct species, as the markings on the underside differ in some respects from those of typical *Z. attilia*. The latter is very common in the Bukenji Woods, near Kanagawa, Yokohama, Honshu.

ZEPHYRUS ATTILIA ab. SUBGRISEA Wileman.

Blackish with a faint purplish tinge; a black mark at end of cell, and indications of the darker under side markings; traces of a bluish white marginal line on each side of the tail. Fringes white. Under side greyish white; fore wings have a brown elongate spot at end of the cell, edged with white and enclosing a faint white line; a brownish, slightly oblique, postmedial band, outwardly edged by a broad white band; the area beyond the band is suffused with brownish and traversed by a submarginal series of white-ringed blackish spots, those towards costa smaller than those towards inner margin, the latter outwardly edged with orange; marginal line blackish; on the hind wings the brown and the white bands are similar to those on the fore wings, but the submarginal spots are less clearly defined outwardly; the outer margin below vein three is orange

enclosing two black spots, that between veins two and three round. Expanse, 32–36 millim. Collection numbers 2017 and 2018. Two specimens from province Yamato, Honshu, July, 1894.

Zephyrus saepestriata Hewitson.

Plate I, fig. 9, larva; fig. 10, food plant.

Japanese name, *uranami-akashijimi.*

Dipsas saepestriata Hewitson, Ill. Diurn. Lep. (1865), 67, Pl. 26, figs. 7 and 8; Pryer, Rhop. Nihon. (July, 1888), 13, Pl. IV, fig. 5.

Zephyrus saepestriata Leech, Butterf. China, Japan, Corea (1892–1894), 2, 384; Stgr. and Rebel., Cat. Lep. Pal. (1901), 1, 71, No. 488; Seitz, Macrolep. of the World, Faun. Pal. (1910), 1, 273, Pl. 74e and f, ♂ and underside; Miyajima, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 183, Pl. XX, fig. 9, ♂; Matsumura, Cat. Insect. Jap. (1905), 1, 18, No. 146; Matsumura, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 126, Pl. 75, fig. 6, ♀.

The larva figured (Plate I, fig. 9) was taken May 20, 1901, at Kobe, Settsu Province, Honshu, on dwarf oak, Japanese name, kunugi (*Quercus serrata* Thumb.); a female imago emerged from the pupa of this larva June 8, 1901.

Larva.—The following description is taken from my original figure: Length, 23 millimeters. Pale green with faint yellow subdorsal oblique streaks on the side; dark spiracles; spines on dorsum highly acuminate on segments 5, 6, 7, and 8; a whitish longitudinal subspiracular line running from head to tail. Miyajima states that the larva of this species feeds on ko-nara, a species of dwarf oak (*Quercus glandulifera* Bl.); Matsumura gives kashiwa (*Quercus dentata* Thunb.).

The imago generally flies among dwarf oaks in the early morning and also again in the evening from 5 o'clock on and is very regular in its time of flight. Japanese professional collectors call it *toki* (time, hour) on account of its punctual habits.

Matsumura records it from Hokkaido (Yezo) and Honshu and from eastern Siberia (Ussuri). I have taken it in Hokkaido and Honshu from May to August. It does not appear to have been recorded yet from Shikoku and Kyushu. It is abundant in the Bukenji Woods, near Kanagawa, Yokohama, where dwarf oak is plentiful.

Genus **ARHOPALA** Boisduval

Arhopala Boisduval, Voy. Ast., Lép. (1832), 75; Seitz, Macrolep. of the World, Faun. Pal. (1910), 1, 274.

Arhopala japonica Murray.

Plate II, figs. 14 and 15, larva, dorsal and lateral aspects; fig. 16, food plant; fig. 17, pupa.

Japanese name, *murasaki-shijimi.*

Amblypodia japonica MURRAY, Ent. Month. Mag. (1875), 11, 170; PRYER, Rhop. Nihon. (1886), 11, Pl. II, fig. 14; LEECH, Butterf. China, Japan, Corea (1892–1894), 2, 344, Pl. 30, fig. 14, ♂.

Arhopala japonica MIYAJIMA, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 173, Pl. XIX, fig. 6; MATSUMURA, Cat. Insect. Jap. (1905), 1, 17, No. 128; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 114, Pl. 74, fig. 7, ♀; SEITZ, Macrolep. of the World, Faun. Pal. (1910), 1, 274, Pl. 75b, ♂♀ and underside.

The larva figured (Plate II, figs. 14 and 15) was taken September 26, 1900, at Yoshino, Yamato Province, Honshu, on evergreen oak, Japanese name, aka-gashi (*Quercus acuta* Thunb.); it pupated September 30, 1900, and a male imago emerged October 5, 1900. I also found larvæ of this species at Kobe, Settsu Province, Honshu, in May, 1901, from which I bred specimens June 7 and 19, 1901, and July 11, 1901. Therefore there are evidently at least two broods in the year, the larva of the first brood being taken in May or possibly earlier, and the larva of the second brood in September or earlier. Matsumura gives *shii* (*Pasania cuspidata* Cerst.) as the food plant.

Seitz states that *A. japonica* is common in the spring and again from August in central and southern Japan and Korea, and that he caught numerous males in flowering fields as late as November. Miyajima gives the time of appearance as May to September for the first brood and September to April for the second brood. Pryer gives September to December and April. I have taken this species in Honshu and Kyushu from May to October, and Matsumura records it from the same islands and from Shikoku. Therefore it may be said that the species occurs in Honshu, Shikoku, and Kyushu from May to the following April. The late imagoes of the second brood frequently appear on sunny days from November to April, flitting about flowers or the branches of the food plant (evergreen oak). Pryer records the fact that the species hibernates. Miyajima also records it from the Loochoo Islands (Ryukyu). In a note written in a copy of Pryer's Rhopalocera Nihonica which I obtained from the Rev. W. Andrews, of Hakodate in Hokkaido (Yezo), it is stated that *japonica* occurs in Hokkaido, but no date of appearance is given. No author, however, appears to have recorded it from that island, and Matsumura distinctly states that it does not occur there.

Larva.—The larva may be described from my original figure as grayish white tinged with yellow; dark mediodorsal, longitudinal stripe edged broadly with yellow; pale subdorsal and subspiracular longitudinal stripes. Length, 19 millimeters.

In the British Museum (Natural History) *Arhopala japonica* Murray is placed as a synonym of *Panchala asinarus* Felder. The type species of *Panchala* Moore is *P. ganesa* Moore. Seitz, however, does not refer to *asinarus* in his description of, and notes on, *A. japonica*, so I have adopted his nomenclature.

Genus CURETIS Hübner

Curetis HÜBNER, Verz. bek. Schmett. (1827), 102; SEITZ, Macrolep. of the World, Faun. Pal. (1910), 1, 276.

Curetis paracuta Nicéville.

Larva and pupa of *Curetis paracuta* Nicéville. Plate II, fig. 18, larva; fig. 19, food plant; fig. 20, pupa, abdominal aspect; fig. 21, pupa, dorsal aspect; fig. 22, ace mark on pupa, enlarged.

Japanese name, *uragin-shijimi.*

Curetis acuta MOORE, Ann. & Mag. Nat. Hist. (1877), IV, 20, 50; PRYER, Rhop. Nihon. (Nov., 1886), 11; (July, 1888), Pl. IV, fig. 1a, ♂; 1b, ♀ (= *paracuta* Nicéville); LEECH, Butterf. China, Japan, Corea (1893), 349 (= *paracuta* Nicéville); MIYAJIMA, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 176, Pl. XIX, fig. 9, ♂; 10, ♀ (= *paracuta* Nicéville); MATSUMURA, Cat. Insect. Jap. (1905), 1, 17, No. 131 (= *paracuta*); MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 123, Pl. 75, fig. 1, ♂ (= *paracuta*); KERSHAW, Butterf. Hongkong (1907), 77, Pl. VIII, fig. 8, ♂; 9, ♀ (= ? *paracuta*); NAWA, Insect World [Konchū Sekai (Jap.)] (1907), 11, 235, Pl. VII, figs. 1–8 (= *paracuta*); SEITZ, Macrolep. of the World, Faun. Pal. (1910), 1, 276.

Curetis truncata MOORE, Ann. & Mag. Nat. Hist. (1877), IV, 20, 51 (= ♀ of *acuta* Moore).

Curetis paracuta NICÉVILLE, Journ. Bomb. Nat. Hist. Soc. (1901), 14, 248.

Curetis japonica FRUHST., Stett. Ent. Zeitg. (1908), 56; SEITZ, Macrolep. of the World, Faun. Pal. (1910), 1, 276, Pl. 75c, ♂ ♀.

Curetis tsushimana FRUHST., Stett. Ent. Zeitg. (1908), 57; SEITZ, Macrolep. of the World, Faun. Pal. (1910), 1, 276.

Seitz [19] gives the following forms of *Curetis acuta*, but does not mention *paracuta* Nicéville, which is the Japanese form or subspecies of *acuta:*

Curetis acuta Moore (♀ = *truncata* Moore) from China is the "darkest form; the black border is so much enlarged that the discal spots are quite small."

Curetis japonica Fruhst. (Plate 75c, ♂ ♀), from Japan; "the red discal spots are larger than in Chinese specimens." Does this equal *paracuta* Nicéville?

Curetis tsushimana Fruhst. from Tsushima Island, between Korea and Kyushu, "has smaller but brighter red discal spots in the ♂, the ♀ being quite black above except for traces of bluish white scaling on the disc."

[19] Macrolep. of the World, Faun. Pal. (1910), 1, 276.

"A fourth form from Ichang, China, which has above a broad, black border and very light yellowish red discal spots, the hindwing being strongly angulate, is considered by Leech to be a form of *angulata* Moore, while Fruhstorfer treats it together with *angulata* as a form of *bulis* Doubl. and Hew. But as I have found in Japan as well as in China at the same place and hour specimens with sharply angulated outer margin to the hind wing and individuals with the hindwing completely rounded, the distinctions in the shape of the wings appear to me to be of doubtful value."

The following description of *Curetis paracuta* Nicéville is given for convenience of reference:

Male.—Upperside, both wings may be distinguished from all known species of the genus by having the red areas of a duller colour, ferruginous rather than cupreous, as usual, the extent of the red coloration varies greatly, in some specimens being twice as great as in others.

Female.—Upperside, both wings differentiated in the same way by the white areas being heavily frosted with bluish scales, the extent of these bluish-white areas being as variable as in the male, and the apex of the forewing also varies in its greater or lesser acumination. All writers on Japanese butterflies have called the species of the genus *Curetis* occurring there *C. acuta* Moore, which was originally described from Shanghai in North China and of which the *C. truncata* of Moore, and the *C. angulata* of Moore, are in my opinion synonymous. *C. acuta* occurs from the eastern coast of China (Shanghai and Hongkong) to the Western Himalayas. The female has the wings above with white central areas. The late H. Pryer's figure of the female of the Japanese *Curetis* is very bad, as it shows the upperside of both wings white instead of bluish white as it is, I believe, invariably. He describes it as "blue."

C. paracuta appears to be a fairly common species in Japan, Pryer giving four localities for it, Leech, the mountains of Central Japan and I have it from Tokyo and Nikko, besides other places not specified.

Habitat: Japan. Expanse: ♂, 2.0 to 2.1; ♀ 2.0 to 2.2 inches.

The larva of *Curetis paracuta* (Plate II, fig. 18) was taken June 4, 1901, at Yoshino, Yamato Province, Honshu, on wistaria, the Japanese name of which is *fuji* (*Kraunhia floribunda* Willd.). It pupated June 6, 1901, and a male imago emerged June 16, 1901. A second larva was taken at Yoshino July 18, 1901. The imago which emerged is no doubt referable to *C. paracuta* Nicéville, which is the Japanese form of the species.

The transformations of *C. acuta* have been figured and described by Nawa. He gives figures of the larva in all its stages, of the pupa, and of the imago, and a general life history.

Larva.—The following is a description of my larva of *C. paracuta* (Plate II, fig. 18) taken from my original figure: Length, 29 millimeters. Dark green; head retractile; segment 4 considerably dilated laterally and vertically so as to form a decided ridge across the segments; spiracles brown ocellated with white; spiracular and subspiracular region paler in color; two semi-

vertical horns on segment 12, base yellow and black-tipped, from these the larva darts filamentary tentacles, when irritated. These tentacles, which are armed with hairs at the apex, strongly resemble the ciliated antennæ of a bombycid moth and are very well represented in Nawa's [20] figure of the full-grown larva. The markings in his figures, however, do not seem to agree well with those of my specimen. Nawa represents his larva as having a series of subdorsal lateral streaks more or less oblique, a supra-spiracular and spiracular line of white dashes, and a rather quadrate white blotch on the side of segment 9. My larva agrees with his in ground color, and as can be seen from the figure is merely of a paler color in the spiracular region. Nawa mentions that the larva exserts tentacles when irritated and gives the food plant as wistaria (fuji). There are, therefore, apparently two forms of the larva. The pupa is figured on Plate II, figs. 20 and 21, and the following description is taken from my original figure:

Pupa.—Dorsum green, speckled lightly with white and marked with the exact facsimile in miniature of a white ace of spades on the thorax; on the underside, wing cases, and abdomen whitish. Nawa in the figure of his pupa also shows the white ace mark. Seitz [21] describes the larva "of the very closely allied (and perhaps not specifically distinct) *C. malayica* Felder" as follows:

> Larva velvety green with a brown head and a dark red oblique lateral stripe on the 3 and 4 segments, posteriorly with a yellow dorsal stripe and on the 9th segment a white quadrangular spot. The projections of the 12th segment yellowish green, the reversible tentacles reddish yellow with black and white hairs at the apex, the tentacles being moved very fast and at once retracted.
>
> The head of the larva is always kept retracted, being hardly visible when the larva is feeding. On *Pongamia glabra.* Pupa semiglobular, transparent greenish, with a yellowish ovate spot on the anterior portion.

A large white spot, more or less rhomboidal, is represented by Nawa on the side of segment 9 of his larva, but in other respects Seitz's description of *malayica* Felder does not agree with the descriptions by Nawa and myself. Bingham [22] also gives a long description of the larva of *Curetis bulis* var. *malayica* Felder.

Matsumura records *C. acuta* from Honshu, Shikoku, and Kyushu. This, no doubt, is *C. paracuta* Nicéville, the Japanese race. I have taken it in Honshu and Kyushu from June to October, and have taken hibernated specimens in the same islands in May.

[20] Insect World (1907), 11, Pl. 7, fig. 5.
[21] Macrolep. of the World, Faun. Pal. (1910), 1, 276.
[22] Fauna Br. India, Butterflies (1907), 2, 446.

There are probably two broods, and it hibernates in the imago form. It never appears to have been taken so far north as Hokkaido (Yezo), where there are five months of rigorous winter with much snow and ice and a very short summer. Miyajima records *acuta* from Loochoo Islands (Ryukyu), but whether or not this is typical *acuta* or *paracuta*, I am unable to say.

Genus ARTOPOËTES Chapman

Artopoëtes CHAPMAN, Proc. Zool. Soc. Lond. (1909), 473. Type, *Lycæna pryeri* Murray.

Artopoëtes pryeri Murray.

Plate II, figs. 23 and 24, larva, dorsal and lateral aspects; fig. 25, food plant; figs. 26 and 27, pupa, dorsal and lateral aspects.

Japanese name, *uragomadara-shijimi*.

Lycæna pryeri MURRAY, Ent. Month. Mag. (1873), 10, 126; PRYER, Rhop. Nihon. (July, 1888), 18, Pl. V, fig. 16; LEECH, Butterf. China, Japan, Corea (1892–94), 2, 313; STGR. and REBEL, Cat. Lep. Pal. (1901), 1, 90, No. 649; MIYAJIMA, Jap. Butterf. [Nihon Chôrui Dzusetsu (Jap.)] (1904), 165, Pl. XVIII, fig. 8, ♀; MATSUMURA, Cat. Insect. Jap. (1905), 1, 20, No. 160; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 112, Pl. 74, fig. 3, ♂; SEITZ, Macrolep. of the World, Faun. Pal. (1909), 1, 322, Pl. 83e, ♂ ♀ and underside.

Artopoëtes pryeri CHAPMAN, Proc. Zool. Soc. Lond. (1909), 473.

The larva figured (Plate II, figs. 23 and 24) was taken June 16, 1902, at Hakodate, Oshima Province, Hokkaido (Yezo), on a species of ? privet, Japanese name, *ibota* (*Ligustrum japonicum* Thunb.). This larva pupated July 3, 1902, and a female imago emerged July 18, 1902. Dörries found the full-grown larva in Sutschan District, eastern Siberia, in June, feeding on *Syringa amurensis* Rupr. This shrub is also found in Japan and is called *hashidoi* in Japanese.

Pupa.—The pupa is attached by a silken pad at the tail with a girdle round the body.

Larva.—The following description of the larva is taken from my original figure: Length, 17 millimeters. Green; a darker longitudinal mediodorsal line; a brown dorsal patch on segments 2 to 4, narrow on segments 2 and 3, and expanding triangularly on segment 4; abdomen whitish; spiracles dark.

Matsumura records this species from Hokkaido (Yezo) and Honshu. Seitz records it from eastern Siberia (Amurland) and Japan. Miyajima states that it flies from May to July. I have taken it in Honshu and Hokkaido in the same months and in Kyushu (Haki, Bungo Province; Shimoshiiba, Hyūga Province) in July. There appears to be only one brood in the year.

HESPERIIDÆ

ISMENINÆ

Genus ISMENE Swainson

Ismene SWAINSON, Zool. Ill. (1820–21), 1, Pl. 16; WATSON, Proc. Zool. Soc. Lond. (1893), 125 (type, *œdipodea* Swainson); MABILLE, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 341.

Ismene aquilina Speyer.

Plate II, fig. 1, head, enlarged; fig. 2, dorsal aspect; fig. 3, larva; fig. 4, food plant; figs. 5 and 6, pupa.

Japanese name, *kibane-seseri.*

Ismene aquilina SPEYER, Stett. Ent. Zeitg. (July, 1879), 346; LEECH, Butterf. China, Japan, Corea (1892–1894), 2, 635; STGR., Rom. Mém. Lép. (1902), 6, 214; MIYAJIMA, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 206, Pl. XXII, fig. 10; MATSUMURA, Cat. Insect. Jap. (1905), 1, 24, No. 195; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 133, Pl. 75, figs. 24, ♂; 20, ♀; STGR. and REBEL., Cat. Lep. Pal. (1901), 1, 94, No. 681; MABILLE, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 342, Pl. 86f.

Ismene jankowskii OBERTH., Diagn. Ask. (August, 1879), 4 (published in Naturae Novitates, Sept., 1879); OBERTH., Etud. d'Ent. (1880), 5, 23, Pl. 1, fig. 2, ♀.

Proteides chrysaeglia BUTL., Proc. Zool. Soc. Lond. (1881), 586.

Pythauria chrysaeglia PRYER, Rhop. Nihon. (Dec., 1889), 33, Pl. X, figs. 5a, ♂; b, ♀.

The larva figured (Plate II, fig. 3) was taken July 21, 1902, at Hakodate, Oshima Province, Hokkaido (Yezo) on a tree named in Japanese *sen-no-ki* (*Acanthopanax ricinifolium* S. and Z.). It pupated July 28, 1902, and a female imago emerged August 13, 1902; three other female imagoes emerged on August 10, 13, and 19, 1902, respectively.

Larva.—The following is a description of the larva taken from my original figure: Length, 41 millimeters. Head ocherish; color brownish with paired vertical lateral yellow streaks on each segment parallel with the segmental divisions; two dorsal yellowish white longitudinal lines, one on each side of the dorsum; yellowish white subdorsal and subspiracular stripes, the latter edged with brown below and then with white; abdomen pale.

Pupa.—Purple-gray with a prominent thoracic horn on apex of head and dusted with a purplish bloom. Attached to leaf by a silken pad by tail and a girdle round the middle of abdomen.

Matsumura records this species from Hokkaido (Yezo), Honshu, and eastern Siberia (Ussuri). Leech remarks that it is

"not rare in the mountainous parts of central Japan and also in Yezo." Pryer records it from Asamayama Mountain and Nikko, both in Honshu, and from Yezo (Hokkaido).

I have taken *Ismene aquilina* in the following localities: Honshu, Yamato Province (Dorokawa, August); Hokkaido (Yezo), Oshima Province (Junsai Numa, July, August); Shiribeshi Province (Iwanai, August); Ishikari Province (Sapporo, August; Jozankei, August). I captured it in great numbers at Jozankei, near Sapporo, where it frequented the flowers of a giant thistle which grew from 2 to 3 meters high. I also found it in profusion on the summit of Raiden Tōge (Pass) on the way to Iwanai in Hokkaido (Yezo). Miyajima gives the time of appearance as July and August which coincides with the months mentioned by me above. In Honshu this species appears to be a mountain butterfly, but in Hokkaido it frequents the plains, being also found in great abundance in the mountains.

Genus **AUGIADES** Hübner

Augiades HÜBNER, Verz. Bek. Schmett. (1827), 112; WATSON, Proc. Zool. Soc. Lond. (1893), 103; MABILLE, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 347.

Augiades ochracea Bremer.

Plate II, fig. 7, larva; fig. 8, food plant; figs. 9 and 10, pupa, dorsal and lateral aspects; fig. 11, head, enlarged; fig. 12, section, dorsal aspect; fig. 13, tail section, dorsal aspect.

Japanese name, *hime-kimadara-seseri.*

Pamphila ochracea BREMER, Bull. Acad. Pétsbr. (1861), 3, 473; BREMER, Lep. Ost.-Sib. (1864), 33, Pl. I, fig. 11.

Augiades ochracea LEECH, Butterf. China, Japan, Corea (1892–1894), 2, 605; STGR. and REBEL., Cat. Lep. Pal. (1901), 1, 93, No. 673; MIYAJIMA, Jap. Butterf. [Nihon Chōrui Dzusetsu (Jap.)] (1904), 199, Pl. XXII, fig. 1, ♂; MATSUMURA, Cat. Insect Jap. (1905), 1, 22, No. 183; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1907), 4, 130, Pl. 75, fig. 14, ♂; MABILLE, Seitz's Macrolep. of the World, Faun. Pal. (1909), 1, 348, Pl. 88c, ♂.

Pamphila rikuchina BUTL., Cist. Ent. (1878), 2, 285.

Hesperia rikuchina PRYER, Rhop. Nihon. (Dec., 1889), 34, Pl. X, fig. 16a, ♀; 16b, ♂.

The larva figured (Plate II, fig. 7) was taken July 29, 1902, at Hakodate, Oshima Province, Hokkaido (Yezo), on bamboo-grass, Japanese name, *sasa-gusa* (? *Lophatherum elatum* S. and Z.). A female imago emerged from the resulting pupa on August 17, 1902. The following descriptions of the larva and pupa are taken from my original figures:

Larva.—Length, 24 millimeters. Head blue-green; body

whitish green; dark green mediodorsal longitudinal stripe; laterally whitish; white subspiracular line.

Pupa.—Green; elongated acuminate thoracic horn; five white lines on the dorsum; attached to leaf of food plant by silken pad at tail and a girdle around the abdomen.

Matsumura records the species from Hokkaido (Yezo), Honshu, and Shikoku and from Korea, eastern Siberia (Ussuri and Amurland), and Manchuria. He says that it is rare in the vicinity of Tokyo, but common at Aomori, in northern Honshu. Miyajima adds Kyushu, and gives the time of appearance from July to August. Butler in describing *Pamphila rikuchina* says that the type "occurs at Rikuchin." There is probably no place of that name in Japan, and "Rikuchin" is doubtless a slip for Rikuchiu Province.

ILLUSTRATIONS

[Drawings by Hisashi Kaidō.]

PLATE I

FIGS. 1 to 8. *Apatura substituta* Butler.
1, larva; *2*, head; *3*, cephalic horn, inside aspect; *4*, view of dorsal tubercle, lateral aspect; *5*, tail, dorsal aspect; *6*, food plant; *7* and *8*, pupa.

9 and 10. *Zephyrus saepestriata* Hewitson.
9, larva; *10*, food plant.

FIG. 11. *Zephyrus attilia* Bremer. Larva.

FIGS. 12 to 16. *Zephyrus orientalis* Murray.
12 and *13*, larva, lateral and dorsal aspects; *14*, food plant; *15* and *16*, pupa, lateral and dorsal aspects.

17 and 18. *Vanessa canace* Linnæus.
17, larva; *18*, food plant.

PLATE II

FIGS. 1 to 6. *Ismene aquilina* Speyer.
1, head, enlarged; *2*, dorsal aspect; *3*, larva; *4*, food plant; *5* and *6*, pupa.

7 to 13. *Augiades ochrace* Bremer.
7, larva; *8*, food plant; *9* and *10*, pupa, dorsal and lateral aspects; *11*, head, enlarged; *12*, section, dorsal aspect; *13*, tail section, dorsal aspect.

14 to 17. *Arhopala japonica* Murray.
14 and *15*, larva, dorsal and lateral aspects; *16*, food plant; *17*, pupa.

18 to 22. *Curetis paracuta* Nicéville.
18, larva; *19*, food plant; *20*, pupa, abdominal aspect; *21*, pupa, dorsal aspect; *22*, ace mark on pupa, enlarged.

23 to 27. *Artopoëtes pryeri* Murray.
23 and *24*, larva, dorsal and lateral aspects; *25*, food plant; *26* and *27*, pupa, dorsal and lateral aspects.

PLATE III

FIGS. 1 to 13. *Diagora japonica* Felder.
1, head, enlarged; *2*, *3*, *4*, and *5*, horn on segments 3, 6, 8, and 11, respectively, enlarged; *6*, anal horns, enlarged; *7* and *9*, adult larva; *8*, cephalic horn, enlarged; *10* and *11*, young larva, lateral and dorsal aspects; *12* and *13*, pupa.

FIG. 14. *Zephyrus attilia* ab. *subgrisea* Wileman. Imago.

PLATE I. JAPANESE LEPIDOPTERA.

PLATE II. JAPANESE LEPIDOPTERA.

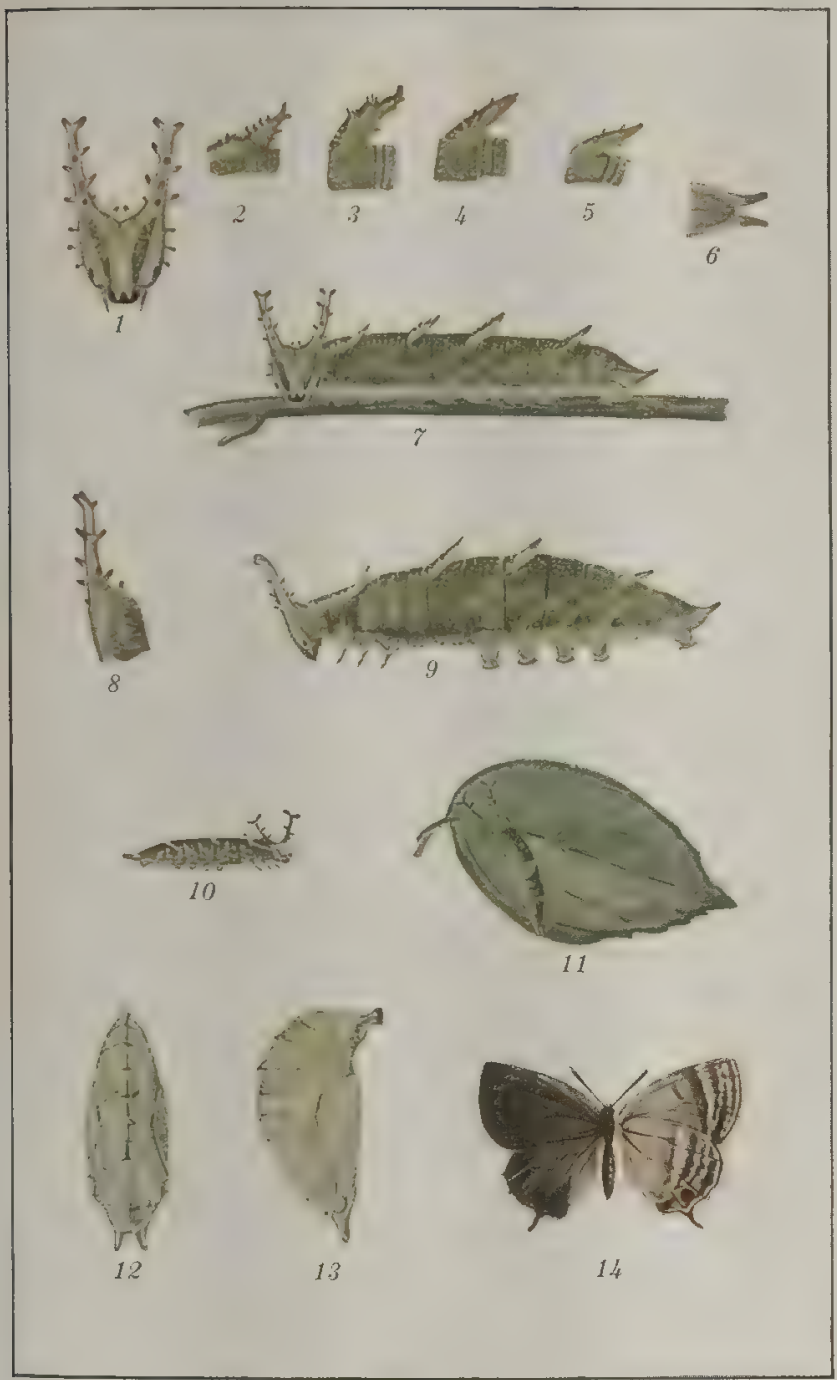

PLATE III. JAPANESE LEPIDOPTERA.

DIFFICULTIES ENCOUNTERED IN THE CULTURE OF THE BAÑGOS, OR MILKFISH, IN ZAMBALES PROVINCE

By ARTEMAS L. DAY

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There are a few marine animals that are cultivated to a great extent and to great advantage in the Philippine Islands and that yield much greater returns than would be obtained without cultivation, and there are many others that might be cultivated with great profit. Among the former are the window-pane oyster (*Placuna placenta*), the pearl oyster, and the edible oyster, of which last there are three species in the Philippine Islands, namely, *Ostrea orientalis*, *O. palmipes*, and *O. pyxidata*, and various fishes, such as the catfishes, hito and candule, the carp (*Cyprinus carpio*) recently introduced from Hongkong into the Philippines, and the bañgos. Among those that might be cultivated may be included sponges, mussels, crustaceans, various button shells, and holothurians or commercial trepang.

Among the cultivated fishes the one that receives the most attention in the region around Manila Bay, as also in various other places, is the bañgos, or milkfish, *Chanos chanos* Forskål. It is cultivated also in a few other regions in the Islands, but nowhere else as yet have very great returns been received. There are still large areas both around Manila Bay and in many other suitable regions where the culture has been scarcely started.

The bañgos are grown in tide ponds, where at the falling of the tide the somewhat stale water is removed and at the rising of the tide the supply of fresh water is replenished. These ponds are supplied with latticed gates, that permit the passage of the water without allowing the fish to escape, and also they are supplied with water-tight gates that will retain the water if desired. The ponds are built in mangrove or other swamps along the seashore or streams. In some of these sites little or no excavation is necessary, in others considerable excavation is necessary in order to make a pond of the desired size. Also in the northern portion of Manila Bay land is "made" by planting small mangrove trees in rather shallow water. These trees hold the sand and soil that is washed up among them. Large areas are

being made in this way. By the time the trees are 4.5 meters high all that is necessary to be done is to throw up high dikes or retaining walls, cut out the trees, and adjust the bottom to the required level.

It should be stated here that it has been learned through observation of the live fish, and through examination of the contents of the digestive tract of these fish, that their food consists of various forms of algæ (called *lumut*) and some flowering plants, that will grow in water of about the density of ordinary sea water.

A few months ago my attention was called to the fact that in Zambales Province difficulties were being encountered in the culture of the bañgos, and an invitation was extended to visit the region in difficulty, with the idea of finding a possible solution. To this end a trip was made to Iba, Zambales. Upon stopping at Subic on the way to Iba, a visit was made to the house of the presidente of the town, with a view to learning about the bañgos culture there. The presidente called in one of the large owners of fish ponds, known as Cando, who was questioned concerning his ponds.

The following is the information collected concerning the various ponds, with occasional comments.

INFORMATION CONCERNING VARIOUS PONDS

SUBIC, POND NO. 1

The owner, Mr. Cando, is greatly discouraged over the results he obtains at present. He has ponds with an area of about 19.5 hectares, which he stocks with 30,000 fry at 50 centavos[1] per 1,000. He stocks his ponds in three installments, the remainder of the small fish being kept in a small pond until desired for use. The small fish are placed in the large ponds in May, September, and January, and are removed in August, December, and April. The ponds are emptied of the large fish each time before restocking. All of these fish are of the same age, those for the restocking being kept in a small pond from spawning time until placed in the large pond. Those placed in the large pond in May are very small, but the others are about 10 centimeters long. Forty per cent of the fish placed in the large pond are eaten by fish other than bañgos, and 30 per cent of the small fish die in the "fry" pond before the transfer. The owner thinks that 60 per cent of his total receipts are lost because of the failure

[1] One peso Philippine currency equals 100 centavos, equals 50 cents United States currency.

of the fish to grow large, and this he attributes to the lack of food. He now receives 1,000 pesos annually from his ponds. The small fish, called "seed," that are caught in April are better than those taken in May and June, because they are from larger and stronger adults. Those taken in May and June are poorest.

The owner thinks that a mud bottom is better for the growth of algæ than a sand bottom.

Because of unsatisfactory conditions in his fish culture, Cando secured the services of some bañgos experts from Malabon, Rizal, to help him solve his difficulties, giving them one third of the output while they were with him. Several suggestions were offered by these men, but so far conditions are not satisfactory.

The large blue crab, *Neptunus pelagicus*, grows well in the ponds.

Some disease, probably due to a fungous growth, has appeared in his ponds.

At Iba there are large areas suitable for bañgos ponds, but their number and extent are not at present very great. Several ponds were visited, both those that were completed and stocked with fish, and those that were in the process of construction, and much valuable and interesting information was secured.

IBA, POND NO. 1

Pond No. 1 at Iba belongs to Mr. José Venzon, and it has been used for thirty years. It contains 18.75 ares. It was constructed at great expense, having been dug out of a level area to a depth of about 3 meters. The owner thinks that from 2,000 to 3,000 fish, valued at 20 centavos each, could be taken from the pond each year if they were permitted to feed on the natural growth of algæ only, without introducing any into the pond. However, through a desire to secure greater results, the owner places 10,000 small fish in the pond, of which two thirds are sold at 5 centavos each. The fry cost 50 centavos per thousand. It will be observed that by allowing for the purchase of 3,000 fry and the sale of 2,000 at 20 centavos each, without adding any food to the pond, the owner would receive more money than if he places 10,000 fry in pond, adds food from the river, and sells 6,600 at 5 centavos each.

By placing in the pond a greater number of fish than the natural growth of algæ will support, and so making necessary the transferring of algæ from the river to the pond at extra cost, the owner of the pond is not only securing smaller fish than, according to his own statement, he would receive by placing a smaller number of fry in the pond (and it would not be necessary to

introduce the algæ without the larger number of fish), but he is also receiving smaller money returns for greater labor.

This pond is situated on the bank of a tide river, where there is plenty of algal growth, and the owner transfers about 2 cubic meters of the algæ from the river to the pond each week, at a cost per week of 60 centavos. This is done from May to September only. The owner thinks that because of the increase of the cost of labor of over 300 per cent, since the construction of this pond, it would not be advisable to make other ponds by excavation.

From the condition of the bottom of the pond it is seen that no accumulation of mud from the decay of algæ or other cause is allowed to form. As the soil throughout this whole region is sandy, it will be observed that by preventing the accumulation of any decayed vegetable matter on the bottom of the pond the bottom will continue to be simply bare sand.

IBA, POND NO. 2

Pond No. 2 at Iba belongs to Mr. Pio Acayan. It has an area of about 1.86 hectares. The bottom is largely covered with a thick layer of mud. In a corner of this pond is a smaller one for the fry; it also has a thick layer of mud on the bottom. There is a good growth of algæ in both ponds, and it is especially heavy in the smaller. The bottom of this pond, with its inclosed small pond, has not recently been disturbed at the time of taking out the fish, and the algæ have not been removed.

The conditions in this pond are the most satisfactory of any in Iba. The bottom has a thick layer of mud, and the growth of algæ is very heavy. The conditions here would seem to contradict the idea that sufficient food cannot be obtained for the fish. This is the first pond in Iba where satisfactory food conditions were found to prevail, but because of lack of care in management, poor results were obtained. With proper care this pond should give satisfactory results. Conditions found here contradict the idea of Mr. José Venzon that good and sufficient algæ will not grow in the ponds in Iba. Mr. Acayan said the algæ did not grow well for the first five years after the pond was built, but recently conditions have been much more satisfactory. During the dry season the algæ are scarcer and coarser than in the rainy season and are not eaten so well by the fish. About November the algæ are poorest, and in December, the dry season, algæ begin to grow. These are a little poorer than those of the rainy season. The best algæ, the "salt-water algæ," are to be found in March. The pond is stocked with fish twice a year: namely, in May and

December. By using care—that is, drying the pond and not stocking at once—the owner thinks as good algæ could be obtained in the dry as in the rainy season.

Five thousand fry are needed each time to stock the pond, at 50 centavos per 1,000. Only two fifths of these mature, because of the presence of other fish, such as pompano, bia (*Oxyeleotris* ?), and dalag (*Ophiocephalus striatus* Bloch.) The fish when sold average 23 centimeters in length and sell at 3 for 20 centavos. Because of the small size of the fish, the owner says he gets but 150 pesos per year from their sale. The pond cost 2,000 pesos to build, and the owner is willing to sell for 1,000 pesos.

IBA, POND NO. 3

Mr. Eugenio Frierro is the owner of pond No. 3, which is in process of construction. It will have an area of about 4 hectares, and the cost of construction, including excavation, building of dikes, etc., will be about 500 pesos. The value of the land is 150 pesos.

This pond lies near pond No. 2, belonging to Pio Acayan, and presents about the same conditions. Considerable excavation is necessary, and there are many trees to remove. Soil conditions are about the same as in the other ponds at Iba. There is a mixture of sand and mud, with a decided tendency for the mud to accumulate in the bottom of the pond. Algæ in plenty were found growing, and with proper care given to the regulation of the number of fish in the pond, the same results as in the other ponds in Iba should be obtained.

IBA, POND NO. 4

Pond No. 4 is the second pond of Mr. Pio Acayan. It has an area of about 4 hectares, and will cost approximately 500 pesos to construct. The bottom has a little more mud than that of José Venzon, although the conditions are almost identical.

IBA, POND NO. 5

Mr. Pablo Mercado is the owner of pond No. 5, which is located to the north of the town of Iba. This pond is in process of construction, but promises to be satisfactory and profitable. Conditions are much the same as in Iba pond No. 2, the first of Pio Acayan.

IBA, POND NO. 6

Pond No. 6, owned by Mrs. Tranquilina Fierro, contains 50 ares, but can be made to include 100 ares. Thus far construction

has cost 90 pesos, and 300 pesos will be required to double its size and improve it.

Six thousands fry were put in the pond in May, 1915, costing 50 centavos per 1,000. The fish attain a length of 17.5 centimeters, and sell for 7 centavos. Were two thirds of the fish to reach this size, the returns should be 280 pesos annually. At present most of the money is lost because of inability to secure a reliable caretaker.

On the return to Manila a stop was again made at Subic, where several ponds not previously examined were visited.

SUBIC, POND NO. 2

Pond No. 2 is the property of Mr. Mauricio Pagadan. It has an area of 27.5 ares. Two thousand fry are put in, and satisfactory results are obtained.

SUBIC, POND NO. 3

Mr. Santiago Pagadan owns pond No. 3. It has an area of one-half hectare. One thousand fish are sold annually at 8 centavos each. They are left in the "seed," or small, pond for nine months, and in the large pond for three months. When put in the large pond they are already 12.5 centimeters long. At the end of a year the fish are 30 centimeters long. This is considered a very satisfactory pond.

SUBIC, POND NO. 4

Pond No. 4 is the property of Mr. Fabian Villoria. It is by far the most satisfactory and profitable pond examined. The owner states that he places 20,000 fry in the pond, 18,000 of which mature and are sold at 20 centavos each. The algæ grow very well. He does not scrape the bottom when the fish are removed, but simply drains off the water and fills the pond again as soon as the fish are taken out. The owner thinks that the character of the bottom does not matter greatly, although he thinks a sand bottom is somewhat better than a mud bottom. The fish are taken out in April, and the small ones are put in in October. The delay in restocking is due to the danger of the pond being flooded during the rainy season.

SUBIC, POND NO. 5

Pond No. 5 is owned by Mr. Pedro Villamor. It has an area of a little more than 1 hectare. Two thousand fish are placed in this pond twice a year, and about 1,500 are sold each time, yielding about 300 pesos. The pond cost 400 pesos to construct,

and could be purchased for 800 pesos. The owner says that the blue crab, *Neptunus pelagicus*, and hawks catch some of the small fish.

SUBIC, POND NO. 6

Pond No. 6 is the property of Mr. Pedro Villamor, with an area of 3 hectares. It yields 600 pesos per annum.

SUBIC, POND NO. 7

Mr. Pedro Villamor also owns pond No. 7. It has an area of about one hectare. The two ponds, numbers 6 and 7, are considered by the owner to be more profitable because there is a mud bottom, and the fish eat the small algæ growing on the bottom. The algal growth is found also at the surface. The 1-year-old fish are 60 centimeters long and sell at 50 centavos each. On the day I visited this pond, May 17, 1915, the owner had 10,000 fish, about 5 centimeters long and 21 days old, in a small pond about 9 by 12 meters. These were to be placed in the pond in June. The ponds of Subic numbered 5, 6, and 7 are in no danger of flooding by the river and so are stocked early.

Regarding feeding, the owner of ponds Nos. 5, 6, and 7 says the fish do not eat for about two or three hours while the water is entering the pond, as they are trying to find a way of escape while the water is in great commotion. Otherwise they eat at any time, either night or day.

CONCLUSION

At the beginning of this report it is stated that certain difficulties in the culture of bañgos have been encountered at Subic and at Iba, Zambales, especially at the latter place. The chief of these was thought to be due to the unfavorable conditions present that would not permit the necessary growth of algæ for food. It was thought that because of the sandy nature of the soil the algæ would not grow. It was held to be necessary to have a muddy bottom for a sufficient algal growth. And it was insisted by some fish growers that it is necessary at the time of removing the large fish for market not only to empty the pond of water, but to leave it empty long enough to dry the bottom, and even to scrape the bottom thoroughly. There is, however, a difference of opinion about the character of the bottom. Some engaged in fish culture hold that a clean sandy bottom is necessary, and others contend that a mud bottom is much better. In this connection it is interesting to note that those holding these opposite views get what seem to them to be satisfactory results. But the

fact that in order to clean off the bottom it is necessary to remove the algæ would seem to argue in favor of draining off the water only, at the time of removing the fish, instead of scraping the bottom. This will enable the algæ to grow at all levels—at the top and bottom, as well as at intermediate regions.

It has been suggested that an insufficient growth of algæ is responsible for poor results around Iba, but the fact that there was a very abundant growth of algæ in pond No. 2, of Iba, belonging to Mr. Pio Acayan, helps to solve the difficulty of the other ponds. It was stated correctly that in certain ponds there is not produced sufficient food for the number of fish in the ponds. But the difficulty in these places is that more fish are placed in the ponds than their size justifies. It is necessary in all these ponds to arrive at a correct balance between the number of fish in a pond and the amount of food that can be produced there without exhausting the food supply.

In order to test the influence of the two kinds of bottoms on the growth of the algal food, a sample of the bottom was brought from each of two ponds in Iba. The first is from that of José Venzon, pond No. 1 at Iba, the bottom of which the owner said is too sandy to permit of good growth of algæ. This sample was placed in a small aquarium on May 22, with circulating sea water, and on June 4 some small bañgos were introduced. Also a mixed algal growth from a pond near Manila was placed in the aquarium on May 22, and two months later the algæ were growing very satisfactorily, as also the small bañgos. The same conditions were arranged in another aquarium tank, with the difference that a sample from the bottom of Iba pond No. 2 was placed here. The growth of the algæ in this second aquarium appears to be equal to that of the first, and the fish, which show great growth, feed equally well here. These observations agree with the testimony of different owners of fish ponds in Iba and Subig to the effect that the algal food, lumut, will grow equally well in ponds that at least originally have bottoms of very different proportions of mud and sand.

By not disturbing the bottoms of these ponds, whether or not at first they have a large or small amount of mud, there will accumulate a layer of "soil" from the breaking down of the algæ and a gradual washing in of soil from the sides, which seems to be favorable to the best growth of algæ, or lumut.

The question of the identification of the various algæ will not be taken up here, but will be included in another paper dealing with the food of these fishes exclusively.

The general rules which follow may well be observed in the management of bañgos ponds:

1. After the construction of the pond is completed, disturb the bottom and the algal growth as little as possible.
2. Place in the pond only as many fish as can well be fed on the algæ that grow easily and abundantly.
3. Do not stock the pond, either after building or after removing the fish, until there is a sufficient amount of food to insure a steady and rapid growth of the fish.
4. If there are harmful forms, such as other fishes or certain crabs, that get into bañgos ponds, have the pond empty only long enough to remove the troublesome forms, and then fill up the pond at once.
5. Careful, close, and continuous supervision by the owner or some one else thoroughly competent is very essential for the greatest financial returns.

All of the lands in the Philippines that are available for bañgos ponds or that may be made available may very profitably be used for this purpose. At present it is almost universally true that the demand for fish far exceeds the supply, and through the culture of these fish the general supply may be greatly increased.

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